

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization International Bureau



(43) International Publication Date  
8 July 2004 (08.07.2004)

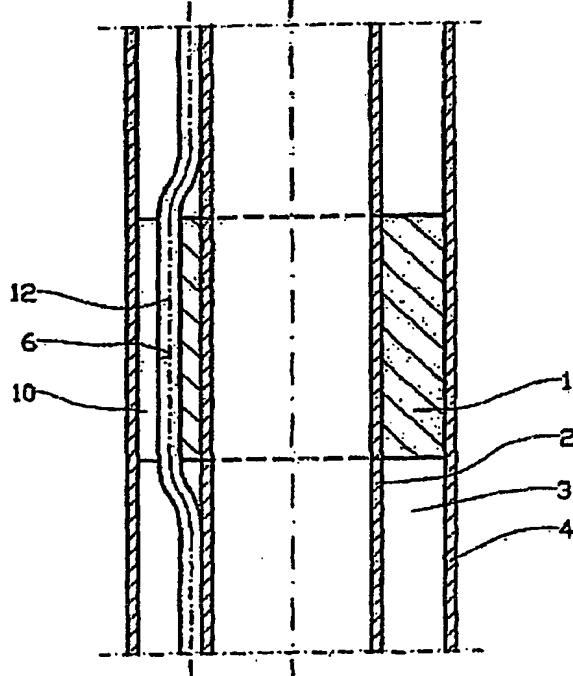
PCT

(10) International Publication Number  
**WO 2004/057715 A3**

- (51) International Patent Classification<sup>7</sup>: **E21B 23/06**
- (21) International Application Number:  
**PCT/NO2003/000410**
- (22) International Filing Date: 9 December 2003 (09.12.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
20035911 10 December 2002 (10.12.2002) NO
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- (81) Designated States (national): AE, AG, AL, AM, AT (utility model), AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ,
- CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EC, EE (utility model), EE, EG, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT (utility model), PT, RO, RU, SC, SD, SE, SG, SK (utility model), SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (regional): ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- Published:  
— with international search report

*(Continued on next page)*

(54) Title: A CABLE DUCT DEVICE IN A SWELLING PACKER



(57) Abstract: A cable duct device in a swellable packer (1) of the kind in which the packer (1) is adapted to be able of sealing an annulus (3), and in which the swellable packer (1) is provided with at least one opening (6) therethrough adapted to constitute a duct for a cable (12).

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— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(88) Date of publication of the international search report:  
14 October 2004

10/538330

WO 2004/057715

PCT/NO2003/000410

Ap/pts<sup>1</sup>  
JC20 Rec'd PCT/PTO 10 JUN 2005

#### A CABLE DUCT DEVICE IN A SWELLING PACKER

This invention relates to a cable duct in a swelling packer.  
More exactly it concerns a cable duct in a swelling packer  
adapted to seal an annulus between a production tubing and a  
casing, for example, or between a production tubing and the  
well formation in a well.

During the completion of a well, in particular a petroleum  
well, by which the well is prepared for production, a cable  
is usually arranged in the well parallel to production tub-  
ing. The cable is protectively arranged on the outside of the  
production tubing.

In this context a cable is intended to be any kind of cable  
or pipe, for example comprising electric lines, optical fi-  
bres, pipe lines for pressurized fluids or injection fluids,  
or combinations thereof. The cable may be adapted to conduct  
signals, supply of energy and chemicals between the surface  
and the well.

The term production tubing is used to illustrate the pipe enclosed by the packer. However, the packer is suitable to seal around any longitudinal body as well.

Due to technical conditions of the formation it may be necessary to provide one or more packers along the production tubing in its longitudinal extension to be able of sectioning the annulus encircling the production tubing.

According to the prior art, inflatable or mechanical expandable packers are used for this purpose. A mechanical expandable packer comprises a flexible material expanding against the casing or the walls of the formation when compressed in the axial direction of the well.

NO 20004509 discloses a swellable packer swelling in volume by the influence from the hydrocarbons of the well, whereby it is sealing against the casing or the walls of the formation.

According to prior art, it has been common to provide the packers with a cable extending through the packer and in which the cable at its end portions on the opposite sides of the packer is provided with connectors for the connection of the cable extending along the production tubing. It is obvious that the connectors of this kind may involve malfunctions, for example in the form of leakage of the pressurized fluids, bad electric contact or penetration of the formation fluids into the connectors. Thus, it is desirable to arrange whole lengths of the cable along the production tubing without having to join the cable at each packer.

US 6173788 discloses a mechanical compressible packer provided with an outer longitudinal slot in which a cable may be arranged. When the packer is compressed and squeezed against the casing, the packer material is brought to squeeze sealingly around the cable. By being situated outside of the packer the cable is relatively poorly protected during the insertion of the production tubing into the well. Obviously, the cable is also subjected to relatively great loads during the mechanical compression. The use of mechanical compressible packers has proved to be unsuitable during the sealing against a well formation as the relative expansion of the packers are insufficient.

The object of the invention is to remedy the disadvantages of the prior art.

According to the invention the object is obtained by means of the features indicated in the description below and the accompanying patent claims.

A packer enclosing a production tubing and being formed from a swellable material is provided with a longitudinal opening therethrough. The opening is adapted to constitute a cable duct. Advantageously, the through-going opening is arranged relatively close to the tubing surface outside of the production tubing. The cross section of the through-going opening may exhibit any geometrical form such as circular or oval. In its longitudinal extension the opening may be straight or have another configuration, for example S-formed or helical.

If desirable the packer may be provided with a slit protruding from the outer circumference of the packer and into the

through-going opening to facilitate placing of the cable in the through-going opening during the assembling work.

When the cable shall be arranged along the production tubing, it is unnecessary to join the cable at the packers. Thus, the 5 cable extends protected in a manner known per se along the production tubing and continues in a protected manner within the through-going opening in the packer to the opposite end portion of the packer, from where it again extends protected along the production tubing.

- 10 After the production tubing is displaced into the well and the swellable material has obtained contact with the swell-activating material, the volume of the packer increases, whereby the packer expands and sealingly encloses the cable and seals against casing or the formation of the well.
- 15 A non-limiting example of a preferred embodiment is described hereinafter which is illustrated in the accompanying drawing, wherein:

Fig. 1 shows in section a packer having two cables arranged therein during insertion into a casing;

- 20 Fig. 2 shows a packer having one cable arranged therein after the material of the packer has swollen sufficiently so as the packer seals around the cable and against the casing;

Fig. 3 shows a section view along I-I in Fig. 1;

Fig. 4 shows a section view along II-II in Fig. 2; and

Fig. 5 shows a section view along IIIa-IIIa in Fig. 2.

In the drawings the reference numeral 1 denotes a packer manufactured from a swellable material, see below. The packer 1 encircles a production tubing 2 and is adapted to be able 5 of sealing an annulus 3 between the production tubing 2 and the shell surface inside of a casing 4.

In its longitudinal extension the packer 1 is provided with an opening therethrough which is preferentially arranged relatively close to the shell surface outside of the produc- 10 tion tubing 2.

Between the cylindrical surface 8 outside of the packer 1 and the through-going opening 6 there is provided a slit 10.

A cable 12 extends through the through-going opening 6.

When the cable 12 shall be arranged along the production tub- 15 ing 2, see Fig. 3, the cable 12 extends along the shell out- side of the production tubing 2, in which it is covered by a protection (not showed) according to prior art.

At the packer 1 the cable 12 extends into the through-going opening 6, in which the material of the packer 1 protects it. 20 As the through-going opening 6 is situated close to production tubing 2, the cable 12 is relatively well protected also at the inlet and outlet of the through-going opening 6.

When the production tubing 2 along with packer 1 and cable 12 are situated in the well, the packer swells and seals the an- 25 nulus 3 by contacting a swell-activating material which may

be of water or hydrocarbons, for example, depending on the material from which the plug is formed.

By swelling in hydrocarbons the packer 1 may be manufactured from a rubber or rubber-like material selected from the group comprising EPDM, styrene-butadiene rubber, natural rubber, ethylene-propylene monomer rubber, ethylene-vinyl acetate rubber, hydrogenated acrylonitrile-butadiene rubber, acrylonitrile-butadiene rubber, isoprene rubber, chloroprene rubber and polynorbornene.

When water shall be the swell-material, the packer 1 may be formed according to US 4137970 disclosing a swellable material casting in which the material manufactured from hydrogen dichromat being dissolved in water is mixed into a compound of glycerol and diethylene glycol. This compound is added a portion of polyacrylamide and then filled into a mould.

If desirable, the swellable material may be enclosed by a web-like material.

In an alternative embodiment the slit 10 may be situated between the through-going opening 6 and the production tubing

2.

In a further embodiment the packer 1 may be formed without the slit 10.

The packer 1 may be constituted by two or more segments together encircling the production tubing 2.

In Fig. 4 an embodiment is showed in which the opening 6 in its longitudinal extension is formed with a bend 14 to provide for a reduced longitudinal stiffness of the cable 12.

If desirable, at least one cable 12 may be arranged on the  
5 inside of the packer (1) in a recess in the shell surface  
outside of the production tubing 2.

C l a i m s

1. A cable duct device in a swellable packer (1) of the kind in which the packer (1) is adapted to be able of sealing an annulus (3) and where the swellable packer (1) is provided with at least one opening (6) there-through adapted to constitute a duct for a cable or pipe (12), characterized in that the swellable packer (1) is provided with a slit (10), the slit (10) passing between the outside surface (8) of the packer (1) and the through-going opening (6).
2. Device according to claim 1, characterized in that the through-going opening (6) encloses the cable (12) both prior to and after the swelling has occurred in the swelling packer (1).
3. Device according to claim 1, characterized in that a cable or pipe (12) is situated on the inside of the packer (1) within a longitudinal recess in the outside of the production tubing (2).

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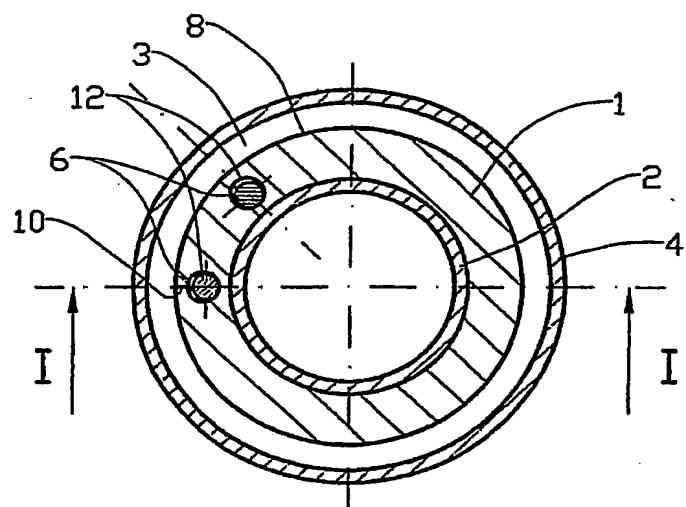


Fig. 1

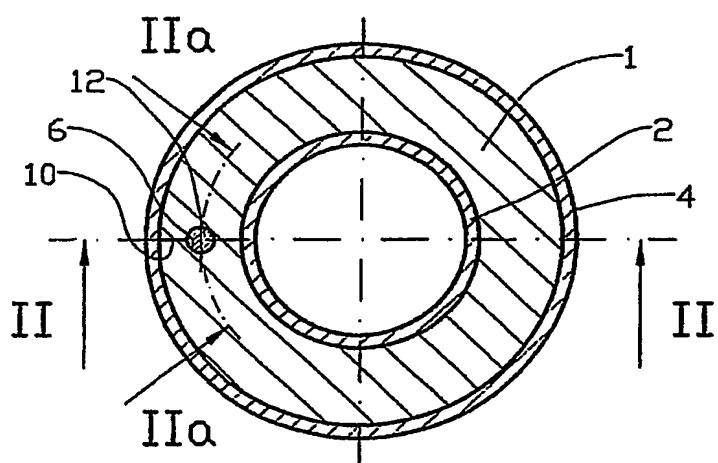
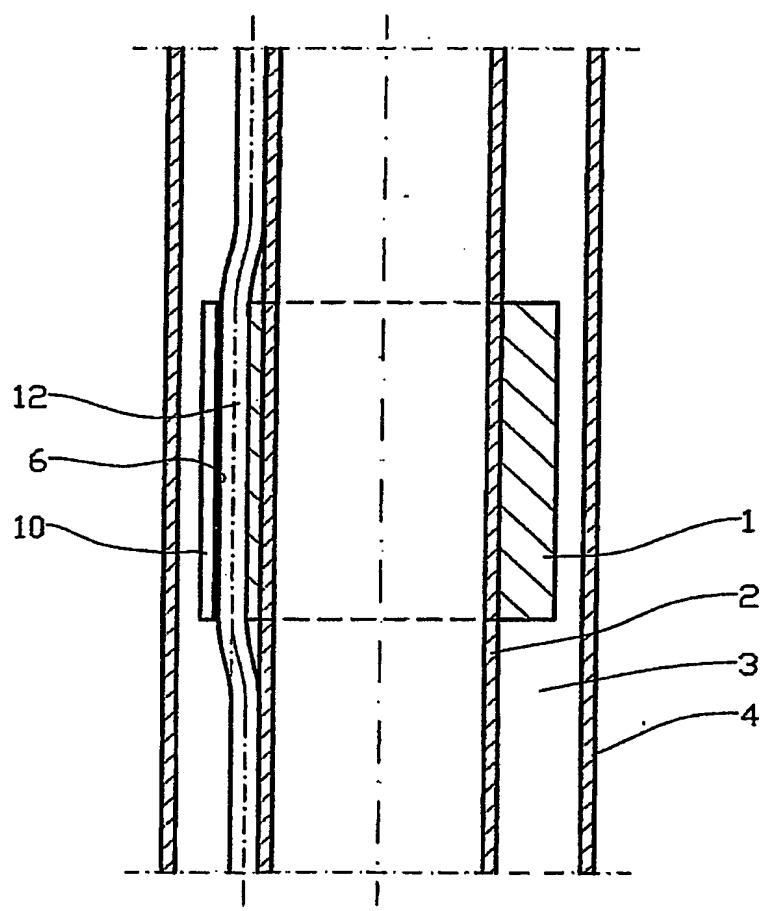


Fig. 2

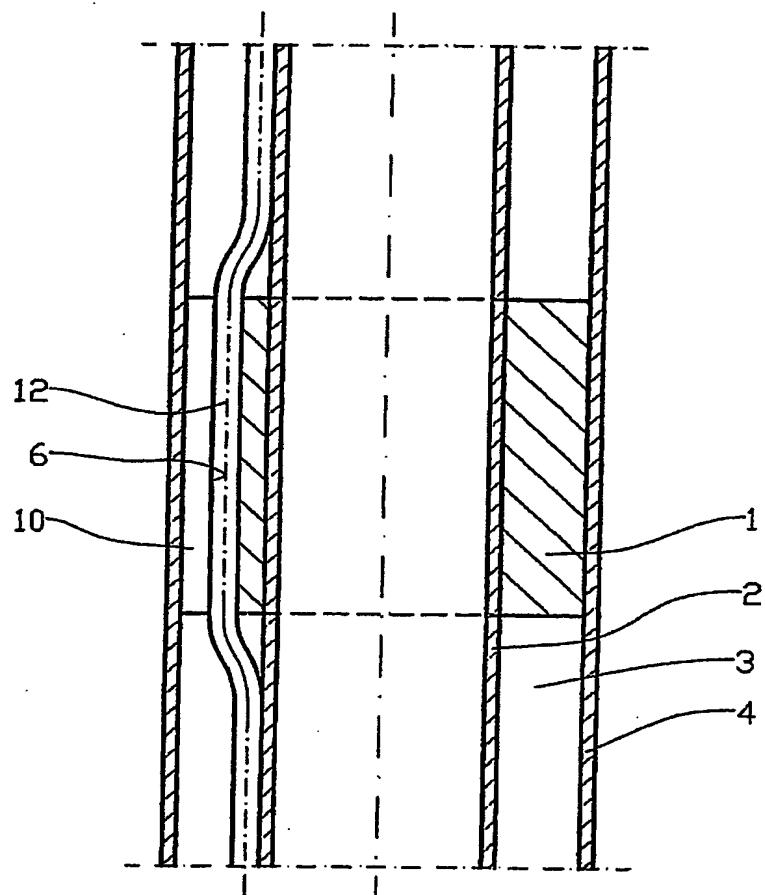
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I-I

Fig. 3

3/4



II-II

Fig. 4

4/4

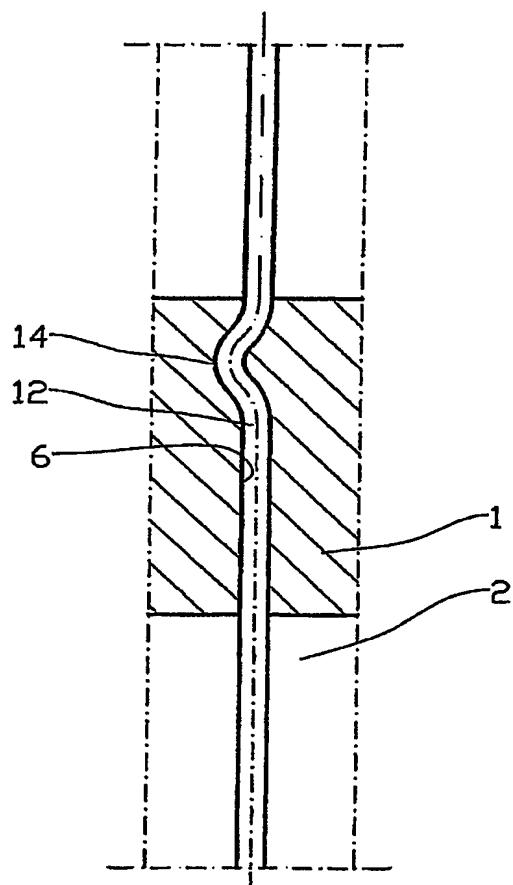
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Fig. 5

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/NO 2003/000410

## A. CLASSIFICATION OF SUBJECT MATTER

**IPC7: E21B 23/06**

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

**IPC7: E21B**

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

**SE,DK,FI,NO classes as above**

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## WPI DATA, EPO-INTERNAL

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6173788 B1 (JEFFREY J. LEMBECKE ET AL), 16 January 2001 (16.01.2001), See whole document --	1-5
X	US 3899631 A1 (BILLY E. CLARK), 12 August 1975 (12.08.1975), see whole document --	1-5
A	US 6135210 A1 (OLEGARIO S. RIVAS), 24 October 2000 (24.10.2000), column 4, line 61 - column 5, line 20 --	1-5
A	US 2242166 A1 (E. O. BENNETT), 13 May 1941 (13.05.1941), figures 3-4 -- -----	1-5

Further documents are listed in the continuation of Box C.  See patent family annex.

* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"B" earlier application or patent but published on or after the international filing date	"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family

Date of the actual completion of the international search

18 August 2004

Date of mailing of the international search report

20 -08- 2004

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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.  
PCT/NO 2003/000410

US	6173788	B1	16/01/2001	GB	2336170 A,B	13/10/1999
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				NO	315437 B	01/09/2003
				NO	991638 A	08/10/1999
US	3899631	A1	12/08/1975	NONE		
US	6135210	A1	24/10/2000	CA	2277566 A	16/01/2000
				GB	2339816 A,B	09/02/2000
				GB	9915984 D	00/00/0000
US	2242166	A1	13/05/1941	NONE		